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(19)

(54) ARRANGEMENT FOR DETECTING SPARKING AT THE BRUSHES OF ELECTRICAL MACHINES

(71) We, VEB ELEKTROGERÄTEWERK SUHL, of 4-12, Werner-Seelenbinder Strasse, 60 Suhl, Thüringen, German Democratic Republic, a Corporation organised under the laws of the German Democratic Republic, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an arrangement for detecting sparking at the brushes of electrical machines with sliding contacts, and evaluating the intensity of said sparking.

The operational reliability and length of life of electrical machines in which, for the transmission of current to a moving part, slip rings, sliding tracks or commutators in conjunction with brushes are employed are governed essentially by the highly stressed brush contact and its wear.

Since the wear of the part contacted by the brush increases markedly with sparking contact, efforts are made to adjust and operate the machine in such a way that sparking at the brushes is either eliminated entirely or kept within an admissible value as regards its intensity. An indispensable prerequisite for this is a method of measuring the intensity of the sparking at the brushes, or for determining the onset of the sparking at the brushes.

It has already been proposed, for the purpose of objective measurement of brush sparking intensity at one or more brushes of a commutating machine, to dispose a photo-electric cell in the range of radiation of the sparking and to have its output signal indicated with an electrical measuring instrument.

The above-described known method of measurement has a number of deficiences. Thus, the measurement result is substantially affected by light from external sources either directly or by its reflection at rotating parts because with the previously known principles of measurement no co-ordination had been achieved with selected parameters of the light originating at the brush spark. Also, when using the known method, it has been necessary either to work in a darkened room or to fit the photo-electric transducer in a closed machine or to screen the external light in the immediate vicinity of the photo-electric transducer. This restriction of the operating conditions raises difficulties for the operators and, in the two last mentioned cases at least, precludes the simultaneous visual observation of the brush sparking. Owing to the space requirements for disposing the photo-electric transducer in the radiation range of the brush sparking, the application of the known method of measurement is confined to medium and large machines.

Similarly, those machines are excluded from the possibility of this measurement in which, owing to the design of their construction, there is no possibility of direct visual observation of the brush sparking.

The necessity, hitherto, to place the photo-electric transducer on the brush, or in the immediate range of radiation of the brush spark, restricts application of the known method of measurement to those cases where there is no risk of mechanical damage to the photo-electric transducer and no need to transmit the measurement data over very long distances.

Previous measurement methods have been directed towards determination of the lateral mean value of the light pulses emanating from the brush sparking. Consequently, however, as is known, the measurement result is in square-law dependence on the distance between the source of radiation and the receiver and furthermore, owing to the width of the brushes which are usually disposed side by side, the measurement result is also de-

pendent on the position of the optical axis of the receiver relative to the brush arrangement.

The aim of the invention is to obviate the existing deficiencies which occur in the known state of the art.

The problem underlying the invention is to produce an arrangement with which it is possible to measure objectively the intensity of sparking at the brushes of any type of electric commutating machine substantially free from the influence of external light and mechanical stresses, wherein the distance of a light sensing device from the sparking region, within a range which is relevant from the technical point of view, has no influence on the result of the measurement and transmissibility of the measurement data over relatively long distances is guaranteed. Moreover, the arrangement should also be suitable for objectively evaluating the intensity of sparking at the brushes on electrical machines with slip rings or slides.

The invention consists in an arrangement for detecting sparking at the brushes of electrical machines with sliding contacts and evaluating the intensity of said sparking, the arrangement comprising a light guide for directly or indirectly picking up light emanating from an edge of a brush during the occurrence of sparking, the light guide being arranged to transmit the light to an opto-electronic transducer which converts the light pulses originating in the sparking into an equivalent electrical signal in the form of pulses, the pulse output of the transducer being connected to electronic circuit means which are tuned selectively to the frequency parameters of the brush sparking and which evaluate the electrical signal by integrating the pulse widths over a given period, the output of said electronic circuit means being connected to an indicating device.

The above-described arrangement can form part of an apparatus for type or serial testing of electrical machines for determining the brush sparking threshold or for the graduation of the intensity of the sparking at the brushes or for determining the cause of brush sparking by the representation, in relation to time, of the electrical and mechanical factors causatively influencing the brush sparking. The arrangement can also form part of an apparatus for the monitoring of operations, indicating damage or for purposes of protection in electrical machines. Furthermore, for electrical machines in adaptive automatic control circuits, the regulating speed and magnitude of the electrical and mechanical parameters can be adjusted optimally, or maximally, with the aid of the measured quantity obtained from the arrangement of the invention.

In order to make the invention clearly understood, reference will now be made to the accompanying drawing which is given by way of example and which illustrates an arrangement for evaluating the intensity of sparking at the brushes of a commutating machine.

The arrangement comprises a light guide 5, preferably a fibre-optics light guide, an opto-electronic transducer 6, electronic circuit means 7 and an indicating device 8. The light guide 5 conducts light from the brush sparking onto the opto-electronic transducer 6. The opto-electronic transducer 6 comprises a semiconductor detector in the form of an integrated component of an amplifier tuned selectively to the frequency parameters of the brush sparking. The amplifier forms part of the electronic circuit means 7. The selectivity of the amplifier ensures that the influence of external light sources on the measurement results is excluded and only the light pulses emanating from the brush sparking are converted into a corresponding electrical signal. Integration of the pulse output of the semiconductor detector with a wide band operational amplifier of a high level of efficiency also makes possible the evaluation of low intensities of light and thus also, besides the direct detection of the light current originating from the sparking at the brushes, also its indirect detection through measurement of the reflection of the brush spark, for example at the internal surface of a machine, by means of the light guide.

The light emanating from the brush spark is generated by short arcs and can be described in its parameters by the intensity and duration of the individual pulses following one another in time. The signal emitted by the opto-electronic transducer 6 is equivalent in its behaviour with respect to time to the light current detected by the light guide. This signal is passed to the electronic circuit means 7 in which integration of the pulse widths over a given time period is effected. An output signal of the electronic circuit means 7 is indicative of the degree of brush sparking and is fed to the indicating device 8, which may be an oscillograph. The direct representation on the oscillograph permits selection of the cause of brush sparking in the case of a time-associated representation of the electrical and mechanical quantities of the machine under investigation which are causatively influencing the brush sparking.

The electronic circuit means 7 connected on the output side of the opto-electronic transducer 6 must be adapted to evaluate correctly the signal analogous to the brush sparking in accordance with the degree of

danger to the operational reliability and length of life of the machine under investigation.

On the basis of known physical interrelationships there is a direct connection between the wear of the brushes and the brush-contacted part (commutator, slip ring) and the energy converted in the arc. For arcs of the "short arc" type, among which must be counted the sparking at the brushes, there is furthermore a square-law dependence, on a physical basis, of the energy converted in the arc on the burning duration of the arc. This makes it possible, in evaluating the signal emitted by the opto-electronic transducer, to utilise as a criterion both the pulse power and also the pulse duration or pulse height.

Evaluation of the pulse duration is preferably adapted to estimation of the commutating efficiency of electrical machines when a definite and reproducible distance between the light guide and the sliding contact cannot be maintained or, because of considerable pollution of the light guide, or the air surrounding it, the light intensity cannot be detected proportionally over a fairly long period of time.

The drawing shows a section of a commutating machine with the elements 1, 2 and 3. When the machine is in operation sparking occurs, mainly at the trailing edges of the brushes 4, which is detected with the light guide 5 and converted in the opto-electronic transducer 6 into equivalent electrical pulses. The electronic circuit means 7 transforms this signal in such a way that only the width of the pulse can be utilised for further evaluation. With suitably high amplification in the above mentioned operational amplifier the distance between 4 and 5 thus has no influence on the measurement result which is evaluated.

Depending on requirements, the electronic circuit means 7 delivers an output signal proportional to the pulse duty factor of the pulse train or a signal proportional to the pulse area, which signal is shown by the read-out unit 8.

Owing to the physical relationship between the wear of the brushes and brush-contacted parts, the energy converted in the arc and the duration of burning of the arc, the indicated pulse duty factor is an objective standard of the efficiency of the commutation.

WHAT WE CLAIM IS:—

1. An arrangement for detecting sparking at the brushes of electrical machines with sliding contacts and evaluating the intensity of said sparking, the arrangement comprising a light guide for directly or indirectly picking up light emanating from an edge of a brush during the occurrence of sparking, the light guide being arranged to transmit the light to an opto-electronic transducer which converts the light pulses originating in the sparking into an equivalent electrical signal in the form of pulses, the pulse output of the transducer being connected to electronic circuit means which are tuned selectively to the frequency parameters of the brush sparking and which evaluate the electrical signal by integrating the pulse widths over a given period, the output of said electronic circuit means being connected to an indicating device.

2. An arrangement as claimed in claim 1, forming part of an apparatus for type or serial testing of electrical machines for determining the threshold of brush sparking intensity or for determining the cause of brush sparking by the representation, in relation to time, of the electrical and mechanical factors causatively influencing the sparking at the brushes.

3. An arrangement as claimed in claim 1 forming part of an apparatus employed for monitoring operations, indicating damage, or protective purposes in electrical machines.

4. An arrangement as claimed in claim 1 forming part of an apparatus having an adaptive automatic control circuit using the said evaluated electrical signal whereby the regulating speed and magnitude of the electrical and mechanical parameters of an electrical machine are influenced.

5. An arrangement for detecting sparking at the brushes of an electrical machine with sliding contacts, constructed and adapted to operate substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*